R E P O R T R E S U M E S

ED 018 794 AL 001 208

CENTER FOR RESEARCH IN HUMAN LEARNING, ANNUAL REPORT, 15 JUNE 1966 - 15 JUNE 1967.

MINNESOTA UNIV., MINNEAPOLIS, CTR.RES.IN HUMAN LRN

PUB DATE JUN 67

EDRS PRICE MF-$0.25 HC-$2.08 50P.

DESCRIPTORS- *ANNUAL REPORTS, *LEARNING, *BEHAVIORAL SCIENCE RESEARCH, COGNITIVE DEVELOPMENT, LEARNING THEORIES, VERBAL LEARNING, VERBAL DEVELOPMENT, LANGUAGE RESEARCH, PSYCHOLINGUISTICS, *RESEARCH PROJECTS, *EXPERIMENTAL PSYCHOLOGY,

THE CENTER FOR RESEARCH IN HUMAN LEARNING WAS ESTABLISHED IN JANUARY, 1964 AT THE UNIVERSITY OF MINNESOTA TO "DEVELOP A CONTINUOUS AND CLOSE-WORKING RELATIONSHIP AMONG PSYCHOLOGISTS IN VARIOUS DEPARTMENTS OF THE UNIVERSITY DOING RESEARCH ON HUMAN LEARNING AND ON PROCESSES RELATED TO HUMAN LEARNING." THE AIM OF THE CENTER IS TO SERVE BOTH THE RESEARCH PSYCHOLOGIST AND THE EDUCATOR FACING PRACTICAL APPLIED PROBLEMS. THIS DOCUMENT CONSTITUTES THE NARRATIVE PORTION OF THE ANNUAL PROGRESS REPORT (1966-67) AS SUBMITTED TO THE NATIONAL SCIENCE FOUNDATION AND THE NATIONAL INSTITUTE OF CHILD HEALTH AND HUMAN DEVELOPMENT. PROJECTS ARE BRIEFLY DESCRIBED, INCLUDING RESEARCH PROGRAMS IN--(1) ANIMAL RESEARCH, (2) PERCEPTION AND CHOICE BEHAVIOR, (3) MEMORY AND RECALL, (4) VERBAL AND MOTOR LEARNING AND TRANSFER, (5) VERBAL AND NON-VERBAL COGNITION IN CHILDREN, (6) LEARNING IN CHILDREN, (7) LANGUAGE BEHAVIOR, (8) INSTRUCTION, AND (9) THEORETICAL ISSUES. THE TRAINING PROGRAM CARRIED ON AT THE CENTER IS ALSO BRIEFLY DESCRIBED. APPENDED IS A LIST OF PUBLICATIONS BY THE CENTER STAFF, TRAINEES, AND ASSOCIATES. REPRINTS OF SOME OF THESE PAPERS ARE AVAILABLE TO INTERESTED AND QUALIFIED PERSONS. FOR FURTHER INFORMATION ON THE AVAILABILITY OF THIS DOCUMENT, WRITE TO THE CENTER FOR RESEARCH IN HUMAN LEARNING, 400 FORD HALL, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINNESOTA 55455. (JD)

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ED018794

UNIVERSITY OF MINNESOTA

Annual Report

of the

Center for Research in Human Learning

1966-67

Supported by the National Science Foundation, the National Institute of Child Health and Human Development and the Graduate School of the University of Minnesota

400 Ford Hall, University of Minnesota
Minneapolis, Minnesota 55455

15 June 1967

AL 001 208

Center for Research in Human Learning

Annual Report

15 June 1966 - 15 June 1967

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Preface

This constitutes the narrative portion of the Annual Progress Report of the Center for Research in Human Learning for the period 15 June 1966 to 15 June 1967. The progress report is submitted to the National Science Foundation and the National Institute of Child Health and Human Development as an official report on the third year of support for the Center.

The report of publications at the end of the text has been arranged to facilitate requests for reprints from readers. Insofar as it is possible, the Center will endeavor to supply reprints to other research workers and teachers who need particular articles when we receive specific requests.

Introduction

The Center for Research in Human Learning at the University of Minnesota was established by the Regents of the University in January, 1964. Its major mission is to develop a continuous and close-working relationship among psychologists in various departments of the University doing research on human learning and on processes related to human learning. The Center brings together persons of many viewpoints representing different research interests and different goals, both practical and theoretical. The aim of the Center is to encourage and support research in human learning and to provide a stimulating atmosphere for the discussion and investigation of a wide range of issues, from the theoretical questions about human learning posed by the research psychologist to the practical applied problems faced by the educator.

A grant to support the work of the Center was made by the Graduate School of the University of Minnesota in January, 1964, and annual grants from the Graduate School have continued since that time. Broader financial support for the Center's activities was granted from the National Science Foundation (GS 541) and the National Institute of Child Health and Human Development (HD 01136) for three years beginning in the fall of 1964. In the spring of 1967 these same two agencies granted continuation support for the Center's research program. A related training program was also granted in January of 1965 by the National Institute of Child Health and Human Development (ITI HD 00098).

The original proposal for program project support pointed to the obvious need of our society for a better understanding of the processes involved in altering human behavior. Special notice was given to the demands that are being imposed on our educational system as a result of social change and to the gulf that exists between research on human learning and practices which depend upon the application of this knowledge. The major argument was that there is much to be gained by bringing the laboratory psychologists together with practitioners interested in research in learning and instruction to advance our knowledge of the human learning processes by working in concert. Both should profit from the interaction, should be stimulated to attack new problems, and should, in the long run, work toward bridging the gap that exists.

The faculty members who staff the Center for Research in Human Learning have been drawn from the group of established investigators in the four departments directly involved in the Center, viz., the Institute of Child Development, the Department of Educational Psychology, the Department of Psychology, and the Center for the Study of Programmed Learning. All students in the Center's training program are first accepted into the Ph.D. programs of one of the three participating academic departments and must satisfy all of the requirements of their home departments before being awarded a degree.

The research and training programs of the Center for Research in Human Learning are designed specifically (a) to bring together into fruitful interaction researchers from several departments of the University who have a common interest in the study of learning; (b) to stimulate, encourage, support and facilitate research on learning; and (c) to provide the best and most flexible conditions for training students in the participating departments for research careers in the learning-related area. By being brought into close intellectual contact with other individuals having different interests, employing different techniques and reflecting different theoretical orientations, the participants are influenced and stimulated in significant and productive ways.

The Center attempts to achieve its aims with varied forms of support. It provides funds to the academic departments to secure released time for investigators to conduct research during the academic year and the summer sessions. It provides research equipment, clerical assistance, data processing, computer programming and computer time for research purposes. It organizes symposia with visiting professors, sponsors special courses and programs of instruction, schedules colloquia and provides formal and informal meetings for the generation and criticism of research. It conducts a special training program and arranges for research apprenticeships for predoctoral and postdoctoral personnel associated with the organization. Finally, it supports publications, reports, papers at scientific meetings, and other forms of dissemination of the research and theoretical efforts of its personnel.

While the size of the Center is only a poor indicant of its intellectual expansion, sheer size does give some indication of the Center's increasing activity. In 1963-64, there were a dozen staff members who met to exchange research ideas and to criticize one another's work. In 1964-65, four predoctoral trainees and a secretary joined the Center and an office was opened in one room in the psychology building.

In 1965-66, the staff increased to 15, the number of predoctoral trainees grew to nine and three predoctoral associates were appointed. (Associates are personnel who have the desired characteristics of personnel associated with the Center but who already hold fellowships of their own.) Two postdoctoral trainees arrived to inaugurate the advanced phase of the training program and two special postdoctoral trainees were appointed to engage in specialized training at a very advanced level. The support staff increased to two secretaries, eight undergraduate clerks and research assistants, and one shop man. The space allocated "on paper" to the Center materialized as a result of a major effort on the part of the University administration, and the Center moved into 41 rooms on the fourth floor of Ford Hall. As a further result of University efforts, a library, shop and lounge facilities were added.

In 1966-67, the staff was augmented by the appointment of two staff associates. Thirteen predoctoral trainees were enrolled in the program along with four predoctoral associates. At the postdoctoral level there were four trainees as well as the two special postdoctoral trainees. The support staff was increased by the addition of two new research assistants, a full-time computer programmer and a part-time shop man.

It is anticipated that 1967-68 will see the Center attain full size as far as its training program is concerned. It is expected that the support staff may continue to increase, however, as the research efforts become more complex and the technology more and more complicated.

Center Personnel

Involved in the several programs of the Center are various categories of membership. During the past year, seventeen faculty members, a visiting European professor, two special postdoctoral fellows, four postdoctoral trainees, fifteen predoctoral trainees and four predoctoral associates have been involved in the research and training programs of the Center.

Administration Staff

Principal Investigator: John G. Darley, Chairman, Department of Psychology, University of Minnesota.

Director of Research: James J. Jenkins, Center for Research in Human Learning, University of Minnesota.

Executive Officer: Russell W. Burris, Center for the Study of Programmed Learning, University of Minnesota.

Research Staff

Russell W. Burris, Ph.D., 1958, Indiana University, Associate Professor, Center for the Study of Programmed Learning.
Programmed instruction, learning, achievement motivation.

William R. Charlesworth, Ph.D., 1962, Cornell University, Associate Professor, Institute of Child Development.
Cognitive development, learning, motivation, and attentional processes in children.

John H. Flavell, Ph.D., 1955, Clark University, Professor, Institute of Child Development.
Development of language and cognition.

Paul W. Fox, Ph.D., 1964, Tulane University, Assistant Professor, Department of Psychology.
Human learning and retention, motor skills.

Wells Hively, II, Ph.D., 1961, Harvard University, Associate Professor, Department of Educational Psychology.
Experimental analysis of instruction.

James J. Jenkins, Ph.D., 1950, University of Minnesota, Professor, Department of Psychology.
Psycholinguistics, mediational processes, verbal learning.

Paul E. Johnson, Ph.D., 1964, Johns Hopkins University, Assistant Professor, Department of Educational Psychology.
Learning, verbal behavior.

David L. LaBerge, Ph.D., 1955, Stanford University, Professor, Department of Psychology.
Learning, perception, quantitative theories.

Kenneth MacCorquodale, Ph.D., 1946, University of Minnesota, Professor, Department of Psychology.
Experimental analysis of behavior, verbal behavior.

Daniel C. Neale, Ph.D., 1961, University of Minnesota, Associate Professor, Department of Educational Psychology.
Learning in educational settings, teacher education.

Herbert L. Pick, Jr., Ph.D., 1960, Cornell University, Associate Professor, Institute of Child Development.
Learning, perceptual learning, perceptual development.

Wallace A. Russell, Ph.D., 1949, State University of Iowa, Professor, Department of Psychology.
Motivation, verbal behavior, experimental psychodynamics.

S. Jay Samuels, Ph.D., 1965, University of California, Los Angeles, Assistant Professor, Department of Educational Psychology.
Research in reading, methodological factors affecting paired-associate learning.

Harold W. Stevenson, Ph.D., 1951, Stanford University, Director and Professor, Institute of Child Development.
Learning, reinforcement effects.

Milton A. Trapold, Ph.D., 1961, State University of Iowa, Associate Professor, Department of Psychology.
Learning, motivation, behavior theory.

John C. Wright, Ph.D., 1960, Stanford University, Associate Professor, Institute of Child Development.
Cognition, learning, motivation.

John I. Yellott, Ph.D., 1965, Stanford University, Assistant Professor, Department of Psychology.
Verbal learning, perception.

Mervyn A. Bergman, M.A., 1963, University of Minnesota, Research Fellow, Institute of Child Development.
Instrumentation.

Robin Ladd McEntire, B.A., 1966, Wellesley College, Computer Programmer.

Robert L. Witkofsky, Electronics Mechanic.

Visiting Staff Member

Zofia Babska, Ph.D., 1958, University of Warsaw, Warsaw, Poland.

Special Postdoctoral Fellows

Lawrence I. Mantini, Ph.D., 1965, University of Minnesota, Assistant Professor, Romance Languages.

Cecil Wood, Ph.D., 1963, Yale University, Professor, Department of German.

Postdoctoral Trainees

Leslie B. Cohen, Ph.D., 1966, University of California, Los Angeles. (Traineeship completed, January 1, 1967.)

Peter B. Pufall, Ph.D., 1966, Catholic University, Washington, D. C.

Larry M. Raskin, Ph.D., 1966, McGill University, Montreal.

Robert E. Shaw, Ph.D., 1965, Vanderbilt University. (Second year)

Predoctoral Trainees

John G. Carlson, B.A., 1963, University of Minnesota.

Paul F. Curnow, B.A., 1965, Macalester College.

David G. Doren, B.A., 1962, University of Minnesota.

Jeffery J. Franks, B.S., 1966, Michigan State University.

Robert A. Hoff, B.A., 1966, Wagner College.

Stuart C. Juuti, B.A., 1964, Indiana University.

Terrence J. Keeney, B.A., 1964, University of California.

Barbara E. Moely, B.A., 1962, University of Wisconsin; M.A., 1964, University of Wisconsin.

Alan R. Moffitt, B.A., 1963, University of Western Ontario; M.A., 1965, University of Western Ontario.

William A. Myers, B.A., 1962, Franklin & Marshall College.

Aneita K. Sharples, B.S.Ed., 1963, Bowling Green State University; M.A., 1966, Bowling Green State University.

Daniel W. Smothergill, B.S., 1963, Fairfield University; M.A., 1964, University of Toledo.

Ronald D. Thurner, B.A., 1962, University of Minnesota.

Stephen Winokur, B.A., 1962, City College of New York.

Predoctoral Associates

Terry Halwes, B.A., 1965, Arlington State College, NSF Fellow.

Joseph R. Jenkins, B.A., 1964, Gonzaga University, NDEA Fellow.

Lois L. Loats, B.A., 1966, Indiana University, Woodrow Wilson Fellow.

Frances Wynns, B.A., 1963, Sophie Newcomb College, Tulane University; M.A., 1967, University of Rochester, NIMH Fellow.

The Research Program

All staff members and graduate students are productively engaged in research. Support from the Center for Research in Human Learning is important in providing for the conduct of research, analysis of data, and the writing of articles and reports. Funds from the Center for the release of investigators' time have made possible concentrated research activity and have accelerated the research output of the participants. The research activities of the members can best be described within the nine general areas which follow.

Animal Research

The work of Trapold has continued to be directed at the mechanisms involved in several types of transfer of training. These generally involve learning which occurs independently of specific instrumental acts but which, when overt responding is eventually called for, has strong effects on how rapidly those overt responses will be learned and upon various characteristics of their performance. Much of this work has been concentrated on the specific problem of transfer from classical conditioning to instrumental learning when the CS of the classical conditioning is related to the discriminative stimuli of instrumental learning, and where the UCS of classical conditioning is related to the reinforcer of instrumental learning. Studies have shown that stimuli paired classically with the reinforcer will subsequently more readily gain control over instrumental responses for that reinforcer, and that stimuli paired classically with active nonreinforcement are subsequently inhibitory to instrumental responses based on that reinforcer.

Given these basic findings, work has gone on (a) to inquire about the extent to which this transfer depends upon the same reinforcer being used in both types of learning, (b) to determine what other phenomena characteristic of instrumental responses (e.g., partial reinforcement effects, stimulus generalization, development of learning sets) might also be facilitated or disrupted by various types of classical pretraining, (c) to develop a technique for delivering reinforcement truly independently of the subject's behavior, (thus eliminating the "explanations" of these transfer phenomena which make use of the minimal overt behavioral requirements that are inherent in more usual classical conditioning procedures), and

(d) to test specific predictions that follow from various alternative theories about what is acquired during classical conditioning and how it subsequently comes to exert control over instrumental behavior.

A related series of studies is concerned with acquired stimulus similarity (and distinctiveness) based upon the fact that two stimuli have played a similar (or different) functional role in a subject's past learning history. Thus, investigations have been directed (with little success) at the purported phenomenon of sensory preconditioning in which similarity is acquired by simple virtue of two stimuli having been paired. Temporally, other studies have looked at whether a common history of "being a signal" for a known reinforcing or aversive event will lead two stimuli to acquire functional similarity (with more success here). These studies relate to those described above because they too involve transfer from behaviorally independent learning situations to instrumental learning situations, and because the mechanisms responsible for the transfer here may be the same that mediate transfer in the first group of studies.

MacCorquodale and Stephen Winokur have continued to explore the problem of "latent" conditioning and extinction, phenomena closely related to those being studied by Trapold. These investigators have been interested in the "expectancies" that animals build up when they are fed or not fed in the presence of certain stimuli. Expectancy is tested by observing changes in behaviors previously associated with the feeding stimuli. The aim of the work is to provide an analysis of the necessary conditions for latent learning in the free operant situation. Stephen Winokur's Ph. D. thesis reports one branch of this investigation in detail.

A series of studies on a different question was completed by John Carlson as his Ph. D. thesis. This set of studies was concerned with the effects of interrupting well-practiced response chains, either by occasionally deleting a reinforcement from its accustomed place in the chain or by occasionally interposing an enforced temporal break before permitting the subject to continue with the chain. These variables were studied in an operant conditioning task designed to retain the desirable features of the techniques more commonly used to investigate frustration-type phenomena, but to eliminate some of the shortcomings of those techniques as well. These studies, which employed both rats and monkeys, showed that both methods of interrupting chains produce effects on both

pre- and post-delay behavior, some of which are readily interpretable in terms of frustration theory, but others of which require the postulation of additional mechanisms.

Under the guidance of Dr. J. Bruce Overmier, Paul Curnow has undertaken studies of avoidance learning in goldfish. Dr. Overmier's research has shown a deficit in avoidance learning in goldfish whose forebrains have been surgically removed. Current research attempts to resolve the locus of this deficit asking whether the deficiency is in the classical conditioning or the instrumental conditioning component of the hypothetical two-process avoidance task. Studies to date suggest no difference in the classical conditioning of normal and operated fish.

Predoctoral Center personnel who have worked on the studies cited above include John Carlson, Paul Curnow, Robert Hoff, William Myers, Stephen Winokur and Douglas Gross.

Perception and Choice Behavior

Work in the classical areas of perception carried out by Pick, Daniel Smothergill, and Larry Raskin has focussed on perceptual integration. Part of this research concerns sensory-motor coordination and uses visual distortion such as optical displacement or rotation to aid in understanding such coordination. The initial reaction and subsequent adaptation of subjects to a disturbance of eye-hand coordination provides clues to the structure of such coordination. For example, a study by Smothergill assessed the ability of children and adults to perform a simple tracking task under rotations of the visual field from 0^{o} to 180^{o}. The children showed maximum disruption at 180^{o} distortion while the adults showed maximum disruption at 120^{o}. The results were interpreted as indicating that adults (in contrast to children) were able to adopt a "reversal" strategy for performing under the "fully-reversed" conditions.

A second part of the research has concerned the integration of vision and touch in children. In this connection research has been undertaken investigating the relative prepotency of texture and shape in children's visual and tactual discrimination learning. Investigations have also been made of the biasing effect of texture on tactual judgments of length.

Temporal aspects of perceptual integration have been investigated by Larry Raskin using "apparent movement" or phi phenomenon as a technique. He has found that over a wide age range the perception of apparent movement can be facilitated or inhibited by the presentation of a "strong instance" of the appropriate prior experience.

Pick and Daniel Smothergill have continued their study of an especially interesting case of sensory impairment. Last year they began the study of the perceptual-motor abilities of a patient deprived of proprioception from the neck down as a consequence of nerve damage following a disease. While the patient receives virtually no information via the usual channels, she is able to monitor her movements visually and to make use of some auditory cues resulting from her movements.

Several studies were carried out by Yellott and Paul Curnow dealing with the information content of "second guesses" in a tachistoscopic letter recognition task. The second guess technique, in which the subject makes a second choice following incorrect first responses in a stimulus identification task, has been used in psychophysics to support signal detectability theory. Typically, in forced choice signal detection studies, second guesses are better than chance, indicating that the subject is able to discriminate between stimuli that are below the "recognition threshold." In tachistoscopic letter recognition, however, no indication of better-than-chance second guessing was found, indicating that a "high threshold" (i.e., all or none) model is adequate for this recognition process. In this same study an effort was also made to predict the numerical values of second choice response probabilities using Luce's choice theory. The results indicate that the choice theory predictions are, in general, not correct, very probably because of trial-by-trial fluctuations in response bias. When these local fluctuations were small, the Luce theory did an acceptable job of prediction.

Other studies in choice behavior have dealt with the statistical properties of hypotheses generated in the context of probability learning. In these studies, subjects are run for a time on a simple non-contingent outcome schedule and then shifted onto a 100-100 schedule in which any response made by the subject is "correct." In the latter phase many subjects believe they have finally solved the prediction problem by finding the correct pattern of events. These "operant" hypotheses are the object of interest here. In particular there is

concern with the relationship between the statistical properties of the hypotheses generated under 100-100 contingencies and the previous reinforcement schedule--the idea being to discover how hypotheses are determined by the schedule.

When the subject in a choice reaction time task is told to be "both fast and accurate," his performance reflects an effort to balance out these incompatible goals. The experimenter can influence the balance chosen by the subject, but he cannot control it. Consequently, it is difficult to interpret RT data in an unambiguous fashion. How, for example, does a mean RT of 300 msec. with 10% errors compare with a mean RT of 350 msec. with 5% errors? Which represents better performance? An experimental and theoretical attack has been made on this problem using a two-process model in which the subject sometimes "guesses," i.e., makes a fast anticipatory response and sometimes waits for unambiguous stimulus information before responding. The later process corresponds to the true choice reaction time distribution since it alone involves recognition of the choice stimulus. Using an extension of a model developed by Robert Ollman (at the University of Pennsylvania) it is possible to determine the parameters of the "true" RT distribution regardless of the subjects' disposition to guess. Further work is underway to test the validity of this correction model under a variety of conditions.

A series of studies in perceptual set have been carried out by LaBerge and Yellott, with the assistance of Peter Van Gelder, James Hildreth, Ross Legrand, and Stephen Mullen. The research has used a CDC 160 computer (acquired on a NASA grant) to present stimuli, record responses and analyze results. The experimenters have been able to exercise considerable control over the preparatory set of subjects when they are performing a recognition test. With a simple three stimulus-two response paradigm, the experimenters have at last been able to separately produce both perception biases and response biases by manipulating presentation frequencies and incentives.

Using a random-cue design, it has been possible to compare the time it takes to switch attention from one visual mode to another (colors to digits), with the time it takes to switch from a visual mode to an auditory mode. Preliminary results indicate a sort of "equidistance" effect: the time required to switch attention from one perceptual class to another appears to be independent of the nature of the classes.

One set of studies has attempted to discover whether adding redundant dimensions to a stimulus input will increase the speed of recognition. For example, does a red-1 vs. a green-2 produce shorter latencies than red vs. green, or 1 vs. 2. Two different designs showed that the subject does not process the colors and digits at one time in a parallel fashion, but rather responds on the basis of either one or the other.

Memory and Recall

Studies in memory by LaBerge and Ross Legrand have investigated the process of instructed (active) dropping of simple verbal items from storage. Using a short-term memory design, they have found that instructions to drop one item just before learning the second item significantly raised the probability of recall of the second item. It is assumed that this comes about by reduced interference of the first item as a result of the dropping instruction. Further studies are probing the effect on the second recall of the time interval between presentation of the first item and the instruction to drop it.

Jenkins, Thomas Hyde and Terrence Keeney have conducted a series of studies of associative clustering in recall in which the focus of interest has been on the conditions prevailing at the time the recall list is first heard. All other things being equal, the amount of associative clustering is a monotonic function of the time per item at input. Time being equated, it was found that clustering is drastically reduced by incidental tasks employed at input when these tasks require that the subjects regard the words as objects (e.g., tell whether there is a t or a g in the word; write how many letters there are in each word). But clustering is unaffected by incidental tasks which require the processing of meanings (e.g., tell whether the word is pleasant or unpleasant).

Verbal and Motor Learning and Transfer

A computer-based verbal learning laboratory has been developed this year. It has been used to run a number of paired-associate learning studies. The computer-based laboratory makes use of the Psychology Department's CDC 160 computer to eliminate much of the busy work involved in verbal learning studies, i.e., preparation of randomized lists of

items, item presentation and data recording, and data analysis. The system has been used in two sets of studies. The first dealt with the effects of introducing various numbers of test trials between two consecutive study trials of a paired-associate item. A previous study by Izawa and Estes had shown that increasing the number of tests of an item between reinforcements had a facilitory effect on learning. Yellott (in collaboration with Stephen Mullen and Michael Riegle) confirmed this result and, in addition, showed that the effect is due to the extra time between reinforcements caused by additional test trials rather than any facilitory effects of testing itself. A related set of studies dealt with the effects of experimenter-controlled response time in paired-associate learning. The subjects' response latency in the recall phase of a standard PA experiment is controlled to determine how well a subject can do at various latencies. Initial results indicated a monotonic and rather dramatic increase in correct response probability as the controlled latency was increased from 1 to 16 seconds. Correct response probability was .60 at 1 second, .80 at 16 seconds. Subjects do better the longer they wait--hardly surprising except for the fact that the subjects themselves seem quite convinced that the longer wait does not help them at all.

Other verbal learning studies, using conventional apparatus, have studied the effects of number of response alternatives on "all-or-none" learning and the differential effects of interpolating learned and unlearned items on short-term memory on a paired-associate task.

Fox and Johnson are conducting an experiment on stimulated verbal recall based upon an analysis of word-association data collected from bilingual French-English and English-French subjects with from one to six years of second language training. Fox is continuing his research program on verbal retention. The emphasis is upon the specification of those associative networks which lead to systematic forms of misrecall and those which act to retard forgetting.

Fox and others are engaged in research on the acquisition of complex motor behaviors requiring "time sharing" of both hands for criterion performance. The major objective is a better understanding of the development of coordinated behavior and the establishment of guidelines distinguishing coordinated from noncoordinated skill behaviors.

Fox and Stuart Juuti have collaborated on a study investigating information feedback transformations. Previous research showing retarded rates of acquisition under "difficult" transformations has been replicated; and substantial amounts of positive transfer have been demonstrated when subjects are shifted from complex to more simple linear feedback transformations late in practice.

Jenkins and Jeffery Franks have repeated an experiment by Wickens and Briggs which offered mediated generalization as an explanation of sensory preconditioning in humans. Two new control groups not used by Wickens and Briggs were included. The original work replicated nicely but the two new controls showed as much "mediated generalization" as the experimental groups, although there was no possibility for common responses to mediate the equivalence. More "cognitive" explanations seem indicated.

Neale and Joseph Jenkins continued their explorations of pictures as stimuli in a variety of learning tasks. Jenkins' Ph. D. thesis dealt with the use of pictures versus words as stimuli. He found that pictures were s u p e r i o r stimuli (as judged by speed of learning) even when different pictures were used on each trial for the stimulus being signified and even though he permitted "enriched" words as stimuli which should have provided multiple cues for learning.

Verbal and Non-Verbal Cognition in Children

The acquisition of symbolic representational abilities in children has been a popular subject of research study in the field of developmental psychology. However, relatively little attention has so far been paid to the factors that determine whether or not the child will, in any given problem situation, actively call into s e r v i c e and use those symbolic abilities which he has already acquired, i. e., which are already in his cognitive repertoire. Current r e s e a r c h by Flavell and his students indicates that age or developmental status is one such fact. There appears to exist a systematic time lag between the initial developmental attainment of various symbolic representational capacities a n d their spontaneous utilization by the child as mnemonic aids in recall tasks.

The initial study in this area gave clear evidence that kindergarten children do not s p o n t a n e o u s l y rehearse the

names of objects as a strategy for recalling these objects, despite the fact that they have no difficulty in correctly labeling them when later requested to do so. Thus, while capable of representing objects verbally, they have not yet developed a disposition to exercise this capability as a means to particular cognitive ends. A subsequent study, conducted with Terrence Keeney and Samuel Cannizzo, demonstrated that first-graders who fail to rehearse the object names in this task recall fewer objects than first-graders who do spontaneously rehearse. However, non-rehearsers of this age can readily be induced to rehearse through brief instruction, and they dramatically improve their recall as a consequence. But, when no longer instructed to rehearse, they quickly abandon this symbolic activity and their recall regresses towards its initial level.

Current work focuses on other non-verbal forms of symbolic representation. A recently completed study with David Corsini and Dr. Anne Pick has shown that kindergarten children do not spontaneously make use of available physical models or copies of objects (Bruner's "ikonic representation") as an aid in recalling them: When given a set of paper replicas of an object configuration, first-graders construct a copy of this array for later use in reproducing the latter, whereas kindergarten children do not. Other studies of similar phenomena by Marvin Daehler, Alan Horowitz, Frances Wynns, Barbara Moely, Frances Olson and Terry Halwes are curently in progress. A closely related investigation with Jev Shelton and Scott Miller, also in progress, will attempt to replicate and re-analyze some of the interesting findings in the area of symbolic development which have been described by the Russian Psychologist, Luria.

Charlesworth and Barbara Moely have continued their work with rotation training studies. These studies examine the effects of various training procedures on the acquisition of concepts concerning the effects of rotations on objects (e.g., rotating a container loaded with a sequence of colored blocks). They have been concerned with the reliability and generality of such Piagetian concepts. Standardized motion picture tests were developed last year and further refined this year.

Research this year employed younger children than before (kindergarten-age children) and failed to find any facilitation as a result of training. This suggests, as many other studies now appear to suggest, that the usual learning procedures are not effective unless children are at an age very close to that at which they acquire the concept spontaneously.

Simply giving a young child experience with the task does not produce learning of the concept.

Charlesworth and Alan Moffitt have continued to work on settings and experimental arrangements for evaluating surprise, uncertainty and frustration in young children. In addition, they are attempting to extend their work to include perception studies with very young children (down to the neonate) with adaptation and orientation studies using the heart rate as their indicator response. While the instrumentation problems here are difficult, it appears that a successful instrumentation may be accomplished with the help of the CDC 160 computer. The first target of this research will be a study of the infant's perception of speech sounds using synthetic speech signals in collaboration with Terry Halwes.

Jenkins, Terrence Keeney and Joseph Jenkins have been investigating the oddity problem with three- to five-year-old children. Original training is on a "redundant oddity" problem in which the correct response always consists of the "odd" item but the odd item is always the same physical object. Four- and five-year-olds readily transfer to the full oddity problem with almost no errors. Three-year-olds do not. College student subjects who have been run in groups in demonstrations do not seem to notice that the odd item is always the same physical object; all they notice is the oddity relation.

Drs. Robert Shaw and Peter Pufall have been studying the Piagetian "diagrammatic layout" problem. This problem essentially consists of mimicking another's operations in space. The experimenter has a landscape in front of him and the child has one in front of him. The experimenter makes a placement on his board and urges the child to do the same on his board. The boards may be side by side, rotated, transposed, etc. Shaw and Pufall have written "grammars" (rule sets) to describe the major ways in which children can approach this task. Their approach seems very fruitful. It results in precise descriptions of what the child is doing which far exceed previously available descriptions in adequacy.

Learning in Children

Stevenson has been active in a large-scale project to investigate the interrelationships and correlates of children's

performance on a variety of learning tasks and problem-solving tasks. Large samples of children in several grades and of different intellectual levels have been systematically studied on a set of tasks involving different kinds of learning and problem-solving skills. It is hoped that the research will contribute to a taxonomy of learning tasks and abilities.

Stevenson has also been investigating problems in children's incidental learning. In a series of three studies, a curvilinear relation between chronological age and incidental learning has been found. In an effort to assess the basis of this relation, the effects of instruction, types of materials and mode (visual vs. auditory) have been studied.

Language Behavior

Three kinds of experiments have dominated the work in language behavior. The first are "demonstration experiments," i.e., experiments which only demonstrate what "everyone knows" to be true. These experiments are useful in convincing the skeptics who deny even "what everyone knows" and in suggesting ways of working with language fruitfully.

Examples of such experiments include discriminations between active and passive sentences. William Myers has shown that college subjects cannot produce a passive sentence on request (when that is the only instruction). Ninety percent of them write active sentences like, "The train went very slowly." He went on to show, however, that students can reach a high criterion very rapidly on a sentence sorting task which requires that they correctly sort actives and passives. This kind of experiment demonstrates that the subjects "know" the difference between such sentences but that they do not know what is being asked for without examples.

Miniature linguistic systems form another center of interest. It is readily shown that students can learn a "system" for labeling objects in an experimental language (such as the Esper esperiment) and that the system, rather than the collection of discrete items, is learned. Dr. Donald Foss explored some parameters of such system learning in his thesis and in related studies. Stuart Juuti has studied some interesting cases of assymmetry in transfer between related miniature systems. If, for example, one learns a system where

numbers stand for colors and shapes, it is easy to transfer to a system where the names of colored shapes are the sums or products of those numbers. Very marked positive transfer is seen. Transfer in the reverse direction is difficult to observe since almost no one learns the sum or product systems when they are given them to start with.

John Bransford and Robert Hull worked with Jenkins in showing the "self-repairing" nature of such miniature linguistic systems. If such systems are partially learned, the constraints of the system suffice to yield perfect performance even if one stops giving feedback as to correctness or incorrectness of responses. Irregular matrices do not have this property, of course.

New experiments on language have taken their impetus from the work of Terry Halwes and Dr. Robert Shaw. These investigators began by developing a grammar for ellipses (i.e., acceptable sentence fragments). After a series of experiments to check the grammar, they hit on the notion of testing the adequacy of their grammar by requiring a subject to repeat a sentence with the experimenter and then by asking a question about it (e.g., "Who?", "Did what?", etc.). This natural situation produced abundant ellipses and very stable latencies for the recovery of different portions of sentences.

This productive lead has been generally applied in a series of studies by Jenkins, William Myers and Lois Loats. Subjects are given sentences on which they must operate to produce new sentences. In this way conjunction, embedding, relativization, etc., are being studied as a function of syntactic and semantic aspects of the sentences given to the subjects originally.

Two sets of studies dealing with the perception of speech are in progress. Terry Halwes is working on problems in dichotic stimulation and will spend the summer of 1967 at the Haskins Laboratories in New York City working on this problem. As indicated above, Alan Moffitt and Terry Halwes are preparing an investigation of the perception of speech sounds by infants if the rather formidable instrumental problems can be solved.

Ronald Thurner has been involved with Jenkins in subjective judgments of similarity between phonemes. Previous work by Greenberg and Jenkins has shown that subjective

magnitude estimations of six stop consonants scale in three dimensions and, in general, in the fashion that would be predicted from Jakobsen's distinctive-features model of phonemes. Jenkins and Ronald Thurner are studying data obtained by means of triadic comparisons in order to test the general reliability of the effect.

Instruction

The report of the development of the Algebra Course for Teachers represents the outcome of three years' concern with the general methodology of empirical program development. Hively is expanding the sections on methodology and measurement into a small book, tentatively entitled Methodological Foundations of Programmed Instruction.

Continued preoccupation with definition and measurement of "criterion behavior" resulted in a joint seminar during winter and spring quarters with Jack Merwin devoted to the theoretical foundations of "universe-defined" tests. Recent work by Cronbach has thrown a great deal of light on the field of achievement testing. A practical offshoot of this theoretical work has been the development of a universe-defined system of tests in arithmetic calculation for use in job corps training programs (done in the Minnesota National Laboratory). Rules have been written for generating an indefinitely large number of parallel forms of a test, and Cronbach has supplied a rationale for calculating the reliability of a score derived from any randomly generated form. For tests of addition, subtraction, multiplication and division of whole numbers, fractions and decimals (8 tests in all), the investigators are obtaining reliabilities in the range from .85 to .90.

A similar approach has been taken to the evaluation of the MINNEMAST curriculum materials in which Paul Johnson, Frank Murray, Ronald Thurner, George Rabehl, and Lucie Johnson are involved (along with several other staff members and students not connected with the Learning Center). Johnson and Hively are working on a monograph devoted to curriculum evaluation based on this experience.

Samuels has been active in conducting research in processes involved in learning to read. In one study he showed that while it was possible to get a von Restorff effect (faster learning) of an item isolated from the rest of a list by virtue of the fact that it was printed in red, the advantage did not

transfer when the item was printed in black on the transfer test. In two experiments on the effect of pictures on learning to read, it was found that pictures distracted poor readers from attending to the word. For the poorer readers, the main effect seemed to be poorer learning of the words presented; for the better readers, there was little difference. Samuels also investigated what the effect is on word recognition speed when words are tachistoscopically presented which do not correspond to anticipated word associations. He found that different kinds of word associations may facilitate or interfere with speed of word recognition. In certain treatments subjects reported seeing the correct word at subthreshold speeds.

Burris is engaged in three major instructional research attempts in the Center for the Study of Programmed Learning. The first is foreign language instruction with the special postdoctoral researchers, Wood and Mantini, in German and French respectively. The German research is moving quite rapidly and has had a large-scale field test on the campus of a small Minnesota college during the year (financed by the Hill Family Foundation). Preliminary reports are most favorable. The instructional sequence includes texts, audio tape drills and taped television lectures. Other Center personnel have become interested in theoretical problems arising in the German course. A special seminar concentrated on the evaluation and meaning of the ellipses obtained from the students in the course. Robert Shaw and Terry Halwes joined the group to explore the problems of characterizing the input and "output" grammars related to the course and to attempt to exploit the opportunity to study ellipses in another language under controlled situations.

The French program has devoted intensive work to problems of pronunciation. In particular, attention has been given to the effect of adding visual cues to the auditory cues employed in the usual audio-tape exercise. Work with video tape, demonstrations, explanations and drills showed marked improvement in student performance with respect to pronunciation of French as judged by instructors.

Other major efforts involve instruction in engineering graphics in collaboration with staff from the Institute of Technology, particularly Professor Richard Springer. This work, which has received support from the Hill Family Foundation, is well advanced and has attracted much favorable attention from other schools that are eager to test out the programs.

A new effort this year is the development of a special program for rehabilitation counselors. This work is supported by the Graduate School and is being performed in collaboration with Professor Lloyd Lofquist. It is anticipated that the programs will be of considerable usefulness, not only to counselors, but also to nurses, technicians and others in paramedical areas.

Johnson and his students, especially Ronald Thurner, have been engaged in further studies of the language of science with particular emphasis upon the exact sciences such as physics. In a rather general way, the effort of the research is to reveal the structure of the subject matter in both the formal sense and in the psychological sense that one can use as a model of what it means "to know" a science. Guiding hypotheses for research are taken from the descriptions of scientific theory found in the writings of scientists. Studies currently underway deal with communication, both in the sense of the articulate contents of a science and in the sense of the unspecified art of scientific research.

Ronald Thurner has worked with Ernest Rothkopf and J. Douglas Carroll of Bell Telephone Laboratories, Inc. on research closely related to the work he has done with Johnson.

Theoretical Issues

While almost all of the work listed above is theoretically motivated and plays a role in the context of some theory, most of it is not self-consciously theoretical. For some members of the Center, however, the desire to expand current theory in the direction of adequate formulations of cognitive issues, or simple irritation with the prevailing associationistic theory base in American psychology, have led to explicitly theoretical work. Russell, for example, has turned to the old problem of the relation between rules and associations which is historically characterized by the Lewin-Ach controversy. He and Jeffery Franks have completed a series of studies replicating and clarifying the original experimental work comparing associative effects in the presence or absence of instructions conducive to "associative sets."

At the most general level, a group of staff and students are working at the development of a more precise formulation of what we have come to call "competency" models, stemming

from recent work in psycholinguistics. One begins with the notion that a grammar specifies what the competencies of a native speaker of a language must be. The psychological problem can then be defined as that of describing an automaton which could produce behavioral products described by the grammar. More specific psychological questions deal with how such proficiencies could have been acquired by a child and how the mature speaker accesses or makes use of the knowledge that he must be presumed to have. The theoretical questions with which we are struggling are: (1) the nature of the formal competency description, (2) the relation of the description to the putative automaton, and (3) the relation of the automaton to behavioral data collected in experimentation.

Several extensions of this line of attack are actively being pursued by Center personnel. The most directly applicable is the research by Drs. Shaw and Pufall mentioned above. This research is an instance of our general belief that the approach of Piaget can be viewed as a special case of competency models. The more formal theory being developed here makes the Piagetian notions more specific and explicit. This in turn makes the research work increasingly definite and provides more detailed descriptions of behavior than were possible before. In this working out of the notions of Piaget, we see a clarification of the relation between his work and psychological science in general.

Our educational psychologists have found considerable stimulation in the notion that an academic subject matter may be viewed as a competency that is to be acquired by the students. This leads in turn to the general questions of "what is learned" and the very knotty problem of how one evaluates the extent to which a competency has been acquired.

Our mathematical psychologists have been intrigued by the idea that it may be possible to characterize appropriate aspects of a "structure" which would permit work on optimization problems with regard to learning and which would provide an adequate basis for discussing generalization from one body of substance to another. If one considers all learning problems unique, every instance must be solved empirically. If all learning problems were essentially the same, the problems of learning, instruction, evaluation, etc., could be solved once and then completely generalized. The truth, we assume, lies between these poles. The key question is whether a characterization of structure is the appropriate middle ground which permits and limits generalization.

Our staff in motor skills research are debating questions concerning "what is learned" in the various skilled acts. There appears to be a good chance that rather different models may be worked out for what appear on the surface to be much the same skills and that these differences may then be exposed through generalization and transfer tests.

A series of lectures on generative explanations, mimicking automata and machine and state identification experiments at the beginning of the year provided a focus for discussions within the Center and were related to subsequent discussions of the psychology of subject matter, miniature linguistic systems, computer simulation and philosophical models. A seminar was organized to discuss the direction the theory was taking with local philosophers, anthropologists and mathematicians. We have been fortunate in finding assistance from our colleagues in other departments, particularly Professor Erwin Engeler in mathematics and Professor Richard Kain in electrical engineering; and we have been gratified by the interest shown by staff members in physics, languages, political science, and anthropology, which has in turn led to further suggestions for discussions and research.

A special seminar was given at the meetings of the Midwestern Psychological Association in May devoted to the emergence of a new view of the role of theory in psychology. While this was quite limited by its very nature, it excited a good deal of interest and was very heavily attended.

The Training Program

The Center is not a teaching department of the University; however, the Center supplements the training that its students receive in formal courses in several ways. These are elaborated below under the headings Formal Coursework, Informal Training, and Apprenticeship.

Formal Coursework

The Center offers two kinds of special coursework to supplement the offerings of its participating departments: (1) summer programs which provide very high-level and concentrated instruction related to some particular area of learning, and (2) special seminars during the academic year with visiting faculty members. The express purpose of both of these kinds of special coursework is to provide training in areas which are not represented in great strength by the resident faculty at the University. Both predoctoral and postdoctoral trainees are expected to attend and participate in these special courses.

The first of our summer programs was held during the summer of 1966. This five-week session was titled the Institute on Higher Mental Processes, sponsored by the Center for Research in Human Learning in cooperation with the Summer Session Office, and consisted of three courses offered through the Psychology Department. The courses offered were as follows:

215 SEMINAR: SPECIAL AREAS OF PSYCHOLOGY--PSYCHOLINGUISTICS

A consideration of the relationship between linguistics and psychology and a study of their area of intersection. Linguistic structure is viewed from the point of view of the generative grammarian. This is presumed to constitute the competence of a language user. How this competence is acquired and how it is manifested in linguistic behavior are the questions seen as basic to a psychology of language. Alternative models are critically reviewed. Jerry Fodor, Massachusetts Institute of Technology.

216 SEMINAR: SPECIAL AREAS OF PSYCHOLOGY--
COMMUNICATION DEVICES IN ANIMALS AND MEN

A consideration of the necessary components of an effective communication system for animals and men. Nature of the communicative code, the role of feedback, the part played by learned and innate components of the system will be important topics. Questions concerning the possibility of teaching a system such as a natural human language to animals will be considered. Problems in the production and perception of language will be treated. David Premack, University of California, Santa Barbara.

217 SEMINAR: SPECIAL AREAS OF PSYCHOLOGY--
INFORMATION PROCESSING MODELS FOR COGNITION AND THINKING

An attempt to provide experience with the concepts and investigative techniques of such models to enable students to continue their education in this area and to utilize such techniques when they need them. The models deal with the form, uses, and organization of information in memory, with mediating processes operating on this information and with such complex overt behaviors as problem-solving, language, and skilled performance. The models are concerned with elementary mental processes, with information units, with the problem of what is learned and with the problem of how it is utilized. Walter Reitman, University of Michigan.

The Institute was attended by eleven special postdoctoral fellows who were funded by the Center for Research in Human Learning with training grant funds from grant T01 HD 00098, from the National Institute of Child Health and Human Development:

Dr. Charles Clifton - University of Iowa
Dr. Donald Davenport - St. Louis University
Dr. Philip Gough - Indiana University
Dr. Peter Guthrie - Carleton College
Dr. David Hakes - University of Texas
Dr. David Horton - University of Kentucky
Dr. Paul Kjeldergaard - University of Pittsburgh
Dr. James Martin - Chico State College
Dr. Sheldon Rosenberg - University of Michigan
Dr. Erwin Segal - University of Texas at Arlington
Dr. Walter Stolz - University of Texas

Drs. David Palermo (Pennsylvania State University), James and Sally Koplin (Vanderbilt University), and Joseph DeVito attended on their own funds.

A number of special lectures were given in connection with the Summer Institute. A University lecture was given by Dr. David Premack entitled, "The Nature of Reward" in Mayo Memorial Auditorium on Wednesday evening, June 22.

A lecture for members and associates of the Center for Research in Human Learning was given by Dr. David Palermo on Wednesday, June 29, on the topic, "Influences of Word-Associations on Verbal Tasks of Children and Adults."

On Wednesday, July 6, Dr. Jerry Fodor gave a University address, "Current Trends in Cognitive Psychology," in Mayo Auditorium.

Dr. Arthur Schwartz gave special lectures to Center personnel on Thursday and Friday, July 7 and 8, on the topic "Linguistic Government: Relation Between Semantics and Syntax."

In addition to these lectures, there were a series of research-report lectures that were given by members of the Center and the visitors. These included:

Dr. James Martin, "Relations between Verbal Behavior Experiments and Psycholinguistic Experiments."

Dr. Sheldon Rosenberg, "Associative Processes in Connected Discourse."

Dr. Erwin Segal, "Experiments with Miniature Linguistic Systems."

Dr. James Jenkins, Dr. Donald Foss and Terry Halwes, "Considerations of the C.A.P. Approach to Theory Building."

Dr. Walter Stolz, "Self-Imbedding That Experiments That I Have Done Involved Will Be Discussed."

For the summer of 1967, we have planned an intensive, broadly based course on Behavior Modification and Control. This course, which will meet two hours per day, five days a

week, will be taught each week by a different visiting professor, each of whom has been active in applying laboratory-derived learning principles to practical problems of behavioral manipulation and control. This course is supported in part by the Summer Session of the University. The five visiting professors and their topics are:

Dr. Frank Logan, University of New Mexico, Albuquerque
"Theory for Educational Psychology"

Dr. O. Ivar Lovaas, University of California, Los Angeles
"Behavior Therapy with Schizophrenic Children"

Dr. Peter Lang, University of Wisconsin, Madison
"The Laboratory Study of Fear Reduction and Autonomic Control"

Dr. Lloyd Homme, Westinghouse Research Laboratories, Albuquerque
"Technological Advances and Retreats in the Field of Behavioral Engineering"

Dr. Ogden Lindsley, Children's Rehabilitation Unit, University of Kansas Medical Center, Kansas City, Missouri
"The Wonderful World of Behavior Modification"

This course will be taken by most predoctoral and postdoctoral trainees and will also be open to other qualified students and staff at the University.

For the spring of 1967, the Center organized a special symposium on research with miniature linguistic systems that was conducted in conjunction with the Center's ongoing Verbal Behavior Seminar under the direction of Professor Jenkins. Two visiting professors (Drs. Kirk Smith and Arnold Horowitz) each visited the Center for three days, gave a formal lecture, and met with the seminar to discuss their research with miniature linguistic systems.

Other Formal Training

One major program sponsored by the Center is a lecture series on general issues of learning. These lectures are held

weekly and are attended by members of the Center staff, trainees, associates, and other interested faculty and students. When possible, the lecturer (sometimes a staff member of the Center, sometimes a faculty member at the University of Minnesota who has been working on some learning-related problem, and sometimes a visiting scholar), gives two or three lectures on a single topic, thus having an opportunity to develop issues in some depth. Dr. John Flavell directed the program for the year. A list of these lectures for 1966-67 follows:

Dr. Ulric Neisser University of Pennsylvania	The Old Psychology of Gestalt and The New Psychology of Language
Dr. Kenneth Lovell University of Leeds Leeds, England	Summaries and Research in Cognitive Development
Dr. Irenaus Eibl-Eibesfeldt Max Planck Institute of Behavioral Physiology Seewiesen, Germany	The Interaction of Innate and Acquired Behavior Patterns in Mammalian Ontogeny Ethological Aspects of Aggression
Dr. Anne Treisman Psychological Research *Division, Bell Telephone* Laboratories Murray Hill, New Jersey	Selective Attention
Dr. Remy Droz Behavior Development Laboratory University of Denver	Developmental and Non-Developmental Mental Processes in Piaget's Theory of Perception
Dr. James J. Gibson Cornell University	Relation of Perception to Memory and Learning
Dr. Arnold Horowitz Hofstra University	Experiments on Miniature Linguistic Systems
Dr. Kirk Smith Bell Telephone Laboratories Murray Hill, New Jersey	Rule Learning in the Recall of Structured Letter Pairs

Dr. David McNeill University of Michigan	Cognition and the Problem of Language Acquisition
Dr. Walter Reitman University of Michigan	Computer Simulation: How to Invent What You Need to Know

Wednesday Night Lectures

Dr. Robert Shaw, Dr. James Jenkins, and Terry Halwes	Generative Explanations
	The Organism as a Mimicking Automaton
	Machine and State Identification Experiments
Dr. Gerald Siegel Department of Speech	Experimental Modification of Disfluency in Normal Speakers
Dr. Richard Martin Department of Speech	Experimental Modification of Stuttering
Dr. Harold Stevenson	A Developmental Study of Interrelations and Correlates in Children's Learning, Parts I and *II*
Dr. Russell Burris	Human Learning Research and Instructional Engineering
	Human Learning Research and Instructional Engineering: The Future
Dr. Herbert Feigl Department of Philosophy	Sentience, Sapience, and Selfhood: Some Psychological Embarrassments of Philosophy
Professor David Campbell Department of Psychology	Some Quandaries from Interest Measurement for Learning Theorists
Dr. Paul Johnson	Some Aspects of the Psychology of Subject Matter

Informal Training

A second lecture series is the weekly Center Research Seminar attended by both trainees and staff. At these meetings a student or staff member presents results of recent research or plans for future research in considerable detail. The effort is to provoke criticism and discussion of all aspects of the research including conception, design, execution, analysis, interpretation, and directions for further research. These sessions have proven extremely valuable as a training device in several ways: They provide a testing ground for students. They help demonstrate and teach high standards for research efforts. They keep the Center members informed in a detailed manner about one another's activities. Finally, they help students take an objective critical attitude toward their own work and the work of others. John Carlson, Terrence Keeney and Alan Moffitt organized the programs. Titles of the meetings held in 1966-67 are as follows:

Dr. Peter Pufall	Acquisition and Generalization of Spatial Order Conservation
Dr. Larry Raskin	Perceptual Learning and Apparent Movement
Dr. Harold Stevenson	Incidental Learning
Dr. Joseph Markowitz	Factors Affecting Empirical ROC Curves
Dr. S. Jay Samuels	The Von Restorff Effect, alias Mickey Mouse
Dr. Anne Pick	Intra- and Inter-Modal Transfer of Training
Dr. J. Bruce Overmier	Avoidance Learning in Goldfish With and Without Frontal Lobes
Dr. John Flavell, Samuel Cannizzo, and Terrence Keeney	Verbal Rehearsal and Recall in a Memory Task by First-Grade Children
Helen Wilson	The Effect of Graded Extinction Upon the Conditioned Avoidance Response

Dr. James Turnure	Development of Attention in Children
Ronald Thurner	Non-Metric Multi-Dimensional Scaling Applied to Educational Research
Stephen Winokur	A Case History in Scientific Method--or--Would You Believe No Latent Learning in the Skinner Box?
Dr. Bernard Karmel	Summary of and Thoughts about Hubel and Wiesel
Dr. John Yellott	Correction for Guessing in Reaction Time
Dr. Warren W. Roberts	Hypothalamic Mechanisms for Sexual, Aggressive, and Other Motivational Behaviors in a Primitive Mammal, the Opposum
Dr. Arnold Horowitz and Larry Hutchinson	Discussion of Miniature Linguistic Systems
Dr. Robert Shaw and Terry Halwes	Some Ellipsis Stuff
Daniel Smothergill	Closed-Circuit TV as a Technique in Studying Tracing Behavior
Dr. Alton Raygor and Dr. David Wark	Messing Around with Reading and Study Behavior
Joseph Jenkins and Terrence Keeney	Strategies in the Solution of a Redundant Oddity Problem--4-Year-Olds and College Sophomores Compared
Dr. Harold Stevenson	The Developmental and Comparative Study of Anagrams
Dr. David LaBerge	Latest Research

John Carlson

The Role of Nonreward and Delay of Responding in Some Multiple and Chain Schedules of Reinforcement: The Application of Operant Techniques in the Study of 'Frustration'

The second informal training device is the "research meeting." All Center staff members hold periodic research meetings with their assistants, students and colleagues in which they discuss their own research activities. Such meetings cover a wide range of topics ranging from what area to study next all the way through to details concerning the analysis of a completed study. These meetings are listed in the Center's weekly calendar and students are encouraged to attend as many as possible, including those which may have little to do with the particular problems in which the student may be interested. This kind of meeting provides a realistic look at on-going research projects. The false starts, the good and poor arbitrary decisions, the pilot studies that do (and don't) come out, the errors made, the good guesses, the serendipitous finding, and the bad hypotheses are all seen in their natural habitat. Further, the trainees see in different research workers a variety of ways of coping with the many problems of conducting research.

Depending upon the particular research project, these meetings may be scheduled regularly or may be called as desired. This year four regular groups were meeting. One was a weekly meeting on on-going research on language and verbal behavior. A second met every two weeks to discuss research relating to Piaget's work and the theory of automata. A third met weekly to discuss research on mediational processes in simple instrumental learning. The fourth was concerned with attention, choice behavior and short-term memory.

The second seminar was the most closely structured and organized, as issues in cognitive development were pursued in a series of meetings. The group met to discuss papers they had prepared which were addressed to the theoretical problems surrounding an explanation of cognitive growth and the difficulties modeling self-organizing systems. Some specific considerations were: relevance of current psycholinguistic theorizing to cognitive development; problems of sequential variance and invariance in Piaget's theory (Flavell); some empirical probes at clarifying Piaget's formalization (Pufall); an analysis of

"surprise" as a construct to explain change (Charlesworth); the possibility of automata as models for change (Shaw); an experimental approach for exploring development (Pufall and Shaw); and neurophysiological considerations in modeling cognition and development (Babska). Other participants in the discussions were Pick, Leslie Cohen, Terry Halwes and Aneita Sharples.

In contrast, the group concerned with language behavior was the least structured. This group met every week for lunch and an intellectual diet that ranged over professional problems, research papers, reports of experiments, the generative analysis of Eskimo verbs, demonstrations of synthetic speech, etc. Group size varied from five to twenty depending on circumstances and topics.

Some groups arise as opportunities become available. For example, in December, 1966, 21 people associated with the Center participated in a three-day training program in the use of digital, solid-state equipment sponsored by the commercial firm, Behavioral Research Systems. Small groups have worked from time to time on problems of computer programming or on "rule-governed" behavior. Groups of staff and students sometimes get involved in a theoretical development and meet in small ad hoc gatherings to write papers on certain aspects of their problem. These papers are then circulated to their peers in the Center for criticism and may, in turn, set off other informal meetings of discussion and debate. A series of interdepartmental meetings with philosophers and anthropologists served to introduce interested staff and students to one of the theoretical efforts of the Center personnel.

As the Center grows in activity and visibility, it is inevitable that interest grows on the part of the community as to what the Center is and what kind of work it is doing. We have discouraged most invitations to "show off" the Center in these early years; but, as the program becomes better known, it has become more difficult to refuse. This year we participated in one of the series of programs on the local educational television station, KTCA-TV, "Adventures in Research." Jenkins, Burris, Charlesworth, LaBerge, Wood and Yellott showed some of the work done by the Center and tried to interpret meaningfully the kind of research that is done under its support.

Apprenticeship

Perhaps the single most important form of training that the Center provides is represented by the apprenticeship. All of the other training "points" to this. After their first quarter, all Center students are required to be engaged in research with some member or group of members of the Center staff. It should be noted that this is not a case of doing research for a staff member but, rather, with a staff member. As rapidly as possible, the trainee is expected to assume responsibility for all stages of research from the initiating ideas to the completed report.

To familiarize the students with the on-going research programs of the staff members of the Center, new trainees and associates were given an "orientation program" during their first quarter. As a group, the trainees visited one or two staff members each week, were given a tour of the staff member's laboratory and were given a one- to two-hour lecture on the nature of work that the investigator was pursuing.

During this orientation period, trainees were strongly encouraged to attend research meetings and to familiarize themselves with the various research opportunities open to them so that they would have an informal basis for affiliating with some particular on-going research project.

After the orientation period, the student was expected to affiliate with one of the on-going research projects and to "apprentice" himself to that project for about two quarters. As the student progresses, he is expected to vary his apprenticeship experiences by affiliating with different research projects. During his third year, his apprenticeships become more intense and prolonged and the quality of his work is expected to be that of a Ph. D. thesis (though not of the same quantity). Finally, in his fourth year he is expected to be engaged in independent professional quality research that includes his thesis. Decisions concerning affiliation with research projects are made by the student in consultation with his adviser and the Director of Training of the Center.

Organization and Facilities

Organization

The Center attempts to make the process of administering the Center as simple as possible. Most immediate decision-making is concentrated in an Executive Committee with broad policy decisions residing in an Advisory Council. The current structure is as follows:

Advisory Council

This body determines the broad administrative policy of the Center. It consists of representatives from the President's Office, the Dean of the Graduate School, the Dean of the College of Liberal Arts, the Dean of the College of Education and the Chairmen of the Departments of Child Development, Psychology, and Educational Psychology. The Center staff is represented by the Director of Research and the Executive Officer.

Representatives on the Council this year have been:

Dean Francis M. Boddy
Dr. Russell Burris
Dr. John G. Darley
Dr. James J. Jenkins
Associate Dean Stanley B. Kegler
Vice President Donald K. Smith
Dr. Harold Stevenson
Associate Dean John Turnbull
Dr. Roger E. Wilk

Executive Committee

This committee is charged with the task of administering the Center and making working policy decisions. It consists of a staff member from each of the participating departments and the Director of the Center for the Study of Programmed Learning as well as the Director of Research.

Members this year have been:

Dr. Russell W. Burris
Dr. William R. Charlesworth

Dr. James J. Jenkins
Dr. Wells Hively II
Dr. Milton A. Trapold

Facilities

In October, 1965, the Center moved into quarters on the fourth floor of Ford Hall, a modern classroom, office and laboratory building in the heart of the Minneapolis campus of the University.

The physical plant of the Center consists of 41 rooms for laboratories, offices, meeting rooms and seminars. The Center has established its own specialized collection of books, reprint files and a library of programmed books and instructional devices. The library, a small conference room and a large seminar and conference room have been equipped and furnished by the University by the special allocation of University funds.

In addition to the laboratory rooms available in the Center itself, the staff and trainees have made extensive use of the laboratories of the academic departments associated with the Center--Psychology, Child Development, and Educational Psychology. These include laboratories for animals, children and adults.

In an effort to make it easy to work with children, the Center purchased a mobile trailer laboratory. Since the trailer has been put into service, the demand for its use has been approximately twice that which could be accommodated. It appears likely that it will be in continuous use both through the academic year and the summer to the limit of its capacity.

Because the Center is somewhat removed from the major shop installation of the Departments of Psychology and Child Development, experimenters have felt the need for a small hand-tool shop adjacent to the experimental rooms for servicing and modifying equipment. This need was met by the allocation of funds from the University for this purpose.

The Center has been building its supply of general purpose components of equipment for research purposes and will continue to do so. A noteworthy feature of the laboratories is a CDC 160 computer which NASA supplied for LaBerge for on-line experimentation. Early work with this equipment has

been very rewarding and affords experience with on-line experimentation which we feel will be important for the development of future laboratory facilities and new forms of experimentation.

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